UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Electrification and the Grid of the Future	**)**	**Docket No. AD21-12-000**

PREPARED REMARKS OF JORDAN BAKKE
ON BEHALF OF THE
MIDCONTINENT INDEPENDENT SYSTEM OPERATOR, INC.

Panel 2: Infrastructure Requirements of Electrification

My name is Jordan Bakke, and I am the Director of Policy Studies of the Midcontinent Independent System Operator, or MISO. As the first Commission created RTO, MISO is proud to serve over 15 states ranging from Louisiana to Minnesota, Manitoba, our many stakeholders, and the over 40 million end use customers who rely on our daily reliability and value creation. As such MISO is pleased to participate in this technical conference, and particularly this panel, share information and observations on the impacts and expectations for electrification.

Electrification is one of many elements of potential change facing the MISO region. With the significant portfolio transformation being driven by MISO state policies, utility goals and customer choices, as well as the recognition of more frequent extreme weather events, MISO has engaged in a focused effort around MISO's ability to respond to these changes in a holistic manner. MISO terms these challenges, the Reliability Imperative and we believe there are many actions needed across many electric system actors to address the Reliability Imperative. At its core, MISO's response to the Reliability Imperative is a comprehensive effort to support the reliability, efficiency, and resilience of the MISO grid.[1] The four critical prongs of the effort are: Market Redefinition, Long Range Transmission Planning, Market System Enhancement, and Operations of the Future. Included in MISO's effort is understanding the challenges and opportunities of electrification. MISO expects electrification to have impacts in each of the elements of the MISO Reliability Imperative. MISO's recent Futures Report and Electrification Insights Report helps inform MISO's efforts and priorities going forward relating to electrification.[2] MISO supports the Commission's efforts to highlight the impacts of electrification and facilitate the development of regional solutions to meet each region's unique needs and priorities.

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[1] MISO Reliability Imperative, https://www.misoenergy.org/about/miso-strategy-and-value-proposition/miso-reliability-imperative/; MISO's Response to the Reliability Imperative is available at: https://cdn.misoenergy.org/MISO%20Response%20to%20the%20Reliability%20Imperative%20updated504018.pdf MISO's Response to the Reliability Imperative is intended to be a "living" document that will be continually updated to be responsive to evolving developments.

[2] MISO Electrification Insights Report (April 2021) available at https://cdn.misoenergy.org/Electrification%20Insights538860.pdf; MISO Futures Report (April 2021) available at https://cdn.misoenergy.org/MISO%20Futures%20Report538224.pdf

After many years of negligible load growth, electrification is poised to transform the future of electric utilities and the electric power system with increased and more variable demand. Electrification is the conversion of equipment powered by fossil fuels to equipment powered by electricity. Its impacts include increased and more variable load, changes in seasonal peak, and interactions between electrification and a decarbonizing grid. MISO has sought to understand the evolving nature of changing electricity demand for years. The most recent MISO Futures have evolved its consideration of electrification from only electric vehicles to a broad range of electrification technologies across different consumer sectors.[3]

The upcoming 2021 MISO FORWARD Report examines adjacent sectors to the power industry such as the buildings, high tech and transportation sectors. There were two trends across the various sectors worth noting as it relates to changes in electric demand. The first was electrification as a way to achieve emission goals and cost savings and the second was increased load flexibility through digital control as a way to increase value. These changes manifest in different ways in different sectors, but collectively they will have large impacts on the system demand MISO must serve.

Also of note, MISO recently published the *Electrification Insights* report which details possible sources, locations and impacts of electrification, outlining opportunities and challenges for which MISO and its stakeholders can prepare.[4] As is highlighted below, even moderate levels of electrification with low levels of renewables change the demand on the system — increasing overall energy demand, changing intra-day patterns, and changing annual patterns.

Electrification may have a significant impact on the MISO's regional transmission needs. MISO's Long Range Transmission Planning ("LRTP") is designed to holistically assess the region's future transmission needs in concert with utility and state plans. There is an urgent need for LRTP as customer preferences, decarbonization goals and economics are accelerating fleet transition on the resource side and electrification on the demand side. MISO's LRTP analysis utilizes the new MISO Futures which incorporate 14-232 TWh of electrifiable load across multiple technologies and consumer classes within the next 20 years, as seen in Figure 1 below. It is important to note that MISO does not forecast the electrification penetration to occur immediately, rather it steadily grows over the 20-year study period along with other fleet changes to decarbonize the grid. In this timeframe the LRTP is the primary focus of addressing the implications of an increasingly electrified economy.

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[3] MISO System Forecasting for Energy Planning available at https://www.misoenergy.org/planning/policy-studies/system-forecasting-for-energy-planning/#t=10&p=0&s=FileName&sd=desc; MISO Futures Report (April 2021) available at https://cdn.misoenergy.org/MISO%20Futures%20Report538224.pdf

[4] MISO Electrification Insights Report, Executive Summary (April 2021) available at https://cdn.misoenergy.org/Electrification%20Insights538860.pdf

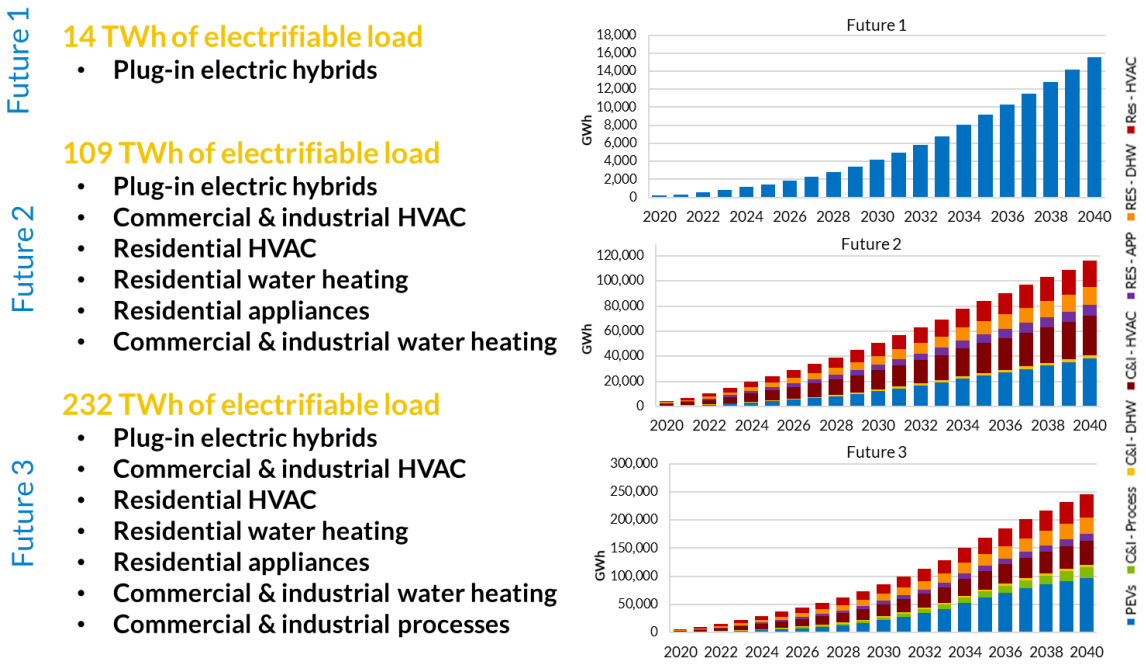


Figure 1: MISO Futures incorporate 14-232 TWh of electrifiable load across multiple technologies and consumer classes

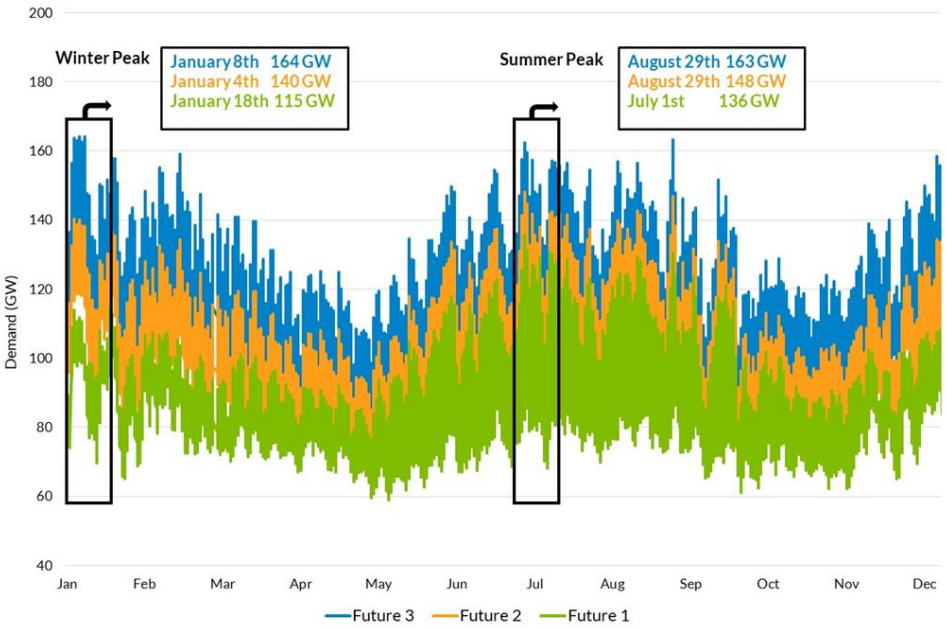


Figure 2: Significant increase in electrifiable loads transforms MISO into a dual summer and winter peaking system by 2039

The LRTP's initial roadmap of infrastructure needs shown in Figure 3 below are large in terms of both generation and transmission, and the specific types and magnitude of investment vary depending on the specific state and member resource plans, decarbonization goals, and the nature of what and where electrification is taking place.

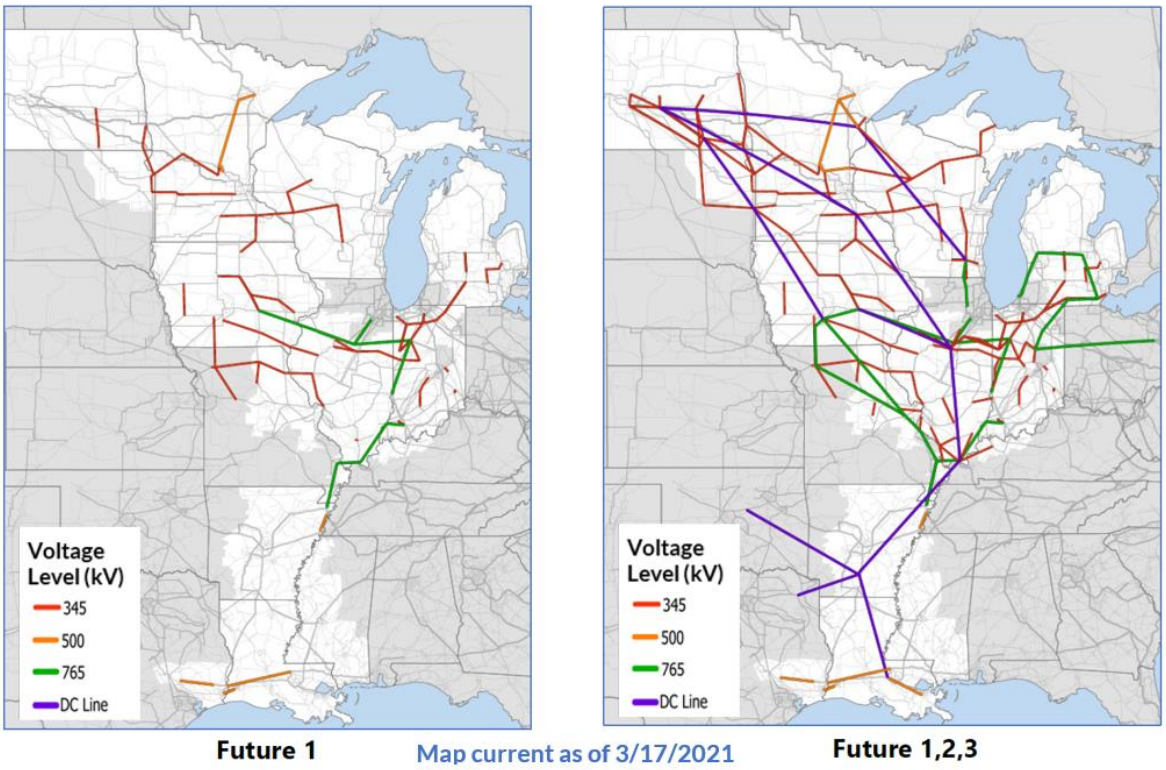


Figure 3: MISO's projected scope of transmission expansion needs is reflected in the initial roadmap for Future 1; the Future 1 roadmap also serves as the starting point for the potential transmission needs in Futures 2 and 3[5]

Transmission is also an important element to deal with the regional, but non-uniform nature of this change. The LRTP process is still ongoing and more information will become available throughout the process on the specific infrastructure investments needed to meet not only the growth in electrification, but also all the other changes the MISO region is experiencing.

While the level and pace of change are outside of MISO's control, it is critical that MISO anticipate the impact of increased electrification within the MISO region in order to maintain reliability at a reasonable cost as the region evolves. Given that electrification is one of many trends (another is the changing resource mix) driving an unprecedented rate of change on the power system, MISO should understand the effect varying levels of electrification may have on its system in the coming decades. The overall goal of the Electrification Insights report is to increase awareness of the potential reliability risks associated with electrification trends and to focus MISO and its stakeholders on working together toward solutions.

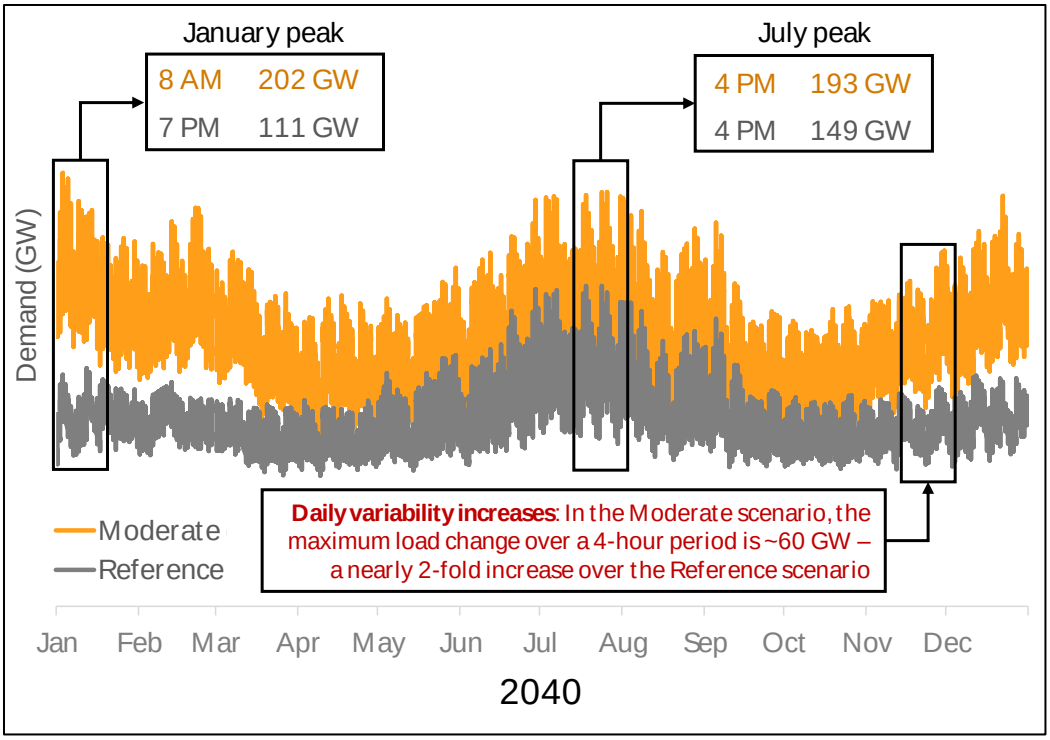
Among the key insights from the *Electrification Insights* report are:[6]

- Shifting Peak Demand Periods - Electrification has the potential to transform MISO system-wide demand from the traditional summer peak to a winter peak. The shift is

[5] From Planning Advisory Committee (PAC) - March 17, 2021: https://cdn.misoenergy.org/20210317%20PAC%20Item%2003a%20Long%20Range%20Transmission%20Plan%20Initial%20Roadmap531009.pdf

[6] MISO Electrification Insights Report, Executive Summary (April 2021) available at https://cdn.misoenergy.org/Electrification%20Insights538860.pdf

predominantly driven by the electrification of heating loads in commercial and residential buildings. As a result, the time of system risk expands to winter mornings and widens over summer afternoons. This may require MISO and MISO members to further evolve processes such as resource adequacy, resource accreditation, system planning, and outage coordination.



- Daily Load Shapes - When examining net load1F1F[7], two daily power demand peaks now appear over nearly all months: one in the morning and one in the evening. This shape change is due to uncontrolled electric vehicle charging and daily heating and cooling loads. This may require both operational changes and changes to the time periods MISO selects for transmission planning.
- Ramp Capability - Electrification requires an increase in ramping services, as the average annual load increases and becomes more variable (right). The increased ramping appears to be linked with uncontrolled charging patterns. This may require MISO and stakeholders to consider how to provide system ramping needs, and whether responsive, flexible, or controllable load should be a part of the strategy to manage ramping.
- Load Control - Although the performance of responsive, flexible, or controllable loads was not included in the work for this report, research suggests that flexible loads have the potential to offset extreme ramps. Flexible load technologies include electric vehicles with vehicle-to-grid capability, water heaters, thermal energy storage, and space heating. This will require additional study and creative, collaborative problem solving with MISO stakeholders.

[7] The expected output from all renewable generation is subtracted from the system load.

- Adoption Rates - Based on the current electrification landscape, some technologies will be adopted because they are cost-effective; others may depend on federal, state, and local policy related to decarbonization. Because electrification is expected to be a key lever for economy-wide decarbonization, this suggests assumptions related to power system decarbonization should continue to include electrification effects, as was done in the MISO Futures.[8]
- Infrastructure Needs - A growing load with a decarbonizing generation fleet will require significant investment (generation and transmission) in the MISO system over the next 20 years. For example, the Low scenario would require around 160 GW of new generation, including more than 60 GW of wind and solar, if 20% of annual energy comes from renewable sources in 20 years.
- Policy Correlation - Economy-wide decarbonization is an important catalyst for electrification, so examining electrification only in the context of a low-renewable system may not identify all system performance risks.

The interplay between an evolving regional resource mix and electrification requires deeper study to ensure that MISO can continue to meet the Reliability Imperative.[9] The four focus areas of the Reliability Imperative seek to ensure that markets, transmissions, operations, and systems — all of which will be directly impacted by electrification — are ready for the coming transition. Even moderate levels of electrification with low levels of renewables change the demand on the system — increasing overall energy demand, changing intra-day patterns, and changing annual patterns — and MISO needs to account for any changes in its planning, operations, and markets. The table below outlines considerations for different MISO processes.

MISO Process	Considerations
Planning	• Continuing to incorporate changing regional load shapes in long-term planning studies to ensure that all periods of system stress are captured.
	• Recognizing that shifting patterns of regional load growth could fundamentally shift flow patterns within MISO. By increasing the wintertime loads in the northern part of the footprint, electrification may contribute to new areas of system congestion and additional opportunities for economic transmission development.
	• Examination into how transmission supports flexible generation that can quickly change its output to provide system ramping needs.
Operations	• Monitoring seasonal load changes within the region. Although the load shape changes result in higher summer and winter peaks, the load levels also increase across all seasons. With long-term

[8] MISO Futures Report (April 2021) available at https://cdn.misoenergy.org/MISO%20Futures%20Report538224.pdf

[9] MISO Reliability Imperative, https://www.misoenergy.org/about/miso-strategy-and-value-proposition/miso-reliability-imperative/

	maintenance outages traditionally taken in the spring and fall, higher "off-season" load may complicate outage scheduling. • Increased visibility into flexible, responsive, or controllable load.
Markets	• The possibility that the market may need to incentivize flexible, responsive, or controllable load as an alternative resource to provide system ramping.

As a result of continued electrification, consumers may rely more on electricity for heat and transportation. We expect electrification impacts may vary across regions based on each. Recent disruptions such as the western heat wave in August 2020 or the cold weather event in February 2021 offer a stark reminder of the importance of the electric supply to consumers. Planning for a reliable system now and in the future remains imperative and a focus of the MISO organization.[10]

There is time to prepare for a future with high load growth in the MISO region, but it is not a time to be complacent as we assess possible future scenarios on the potential demands on the MISO system. As large corporations with substantial presence in the MISO footprint begin their own electrification initiatives, the electrified future could be expedited. For example, several large automakers have announced commitments to phase-out gasoline-powered vehicles from their offerings over the coming decades. MISO, its state regulators, and its stakeholders have a shared responsibility to maintain electric reliability by addressing the holistic needs of the system, including anticipated changes to system load.

MISO appreciates the Commission's forum to share information and observations on the impacts and expectations for electrification. We look forward to continuing to assess the experiences and observations across the industry. MISO continues to be vigilant to all the dynamic changes in our industry to inform our efforts to serve its customers in the regional over the long term in a reliable and cost-effective manner. We will continue to be bringing enhancements to our transmission planning process to facilitate needed regional transmission infrastructure and advance our market design and products to effectively meet the challenges ahead.

Respectfully submitted,

/s/ Jordan Bakke

Jordan Bakke

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[10] MISO's Response to the Reliability Imperative (February 2020) is available at: https://cdn.misoenergy.org/MISO%20Response%20to%20the%20Reliability%20Imperative%20updated504018.pdf